CSc 174 Database Management Systems

9. Normalization (Review)

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What is normalization?

- **Normalization**: The process of decomposing unsatisfactory relations by breaking up their attributes into smaller relations
  - Use
    - keys
    - FDs

  to certify whether a relation schema is in a particular normal form

Definitions of Keys and Attributes Participating in Keys

- A **superkey** of a relation schema $R = \{A_1, A_2, ..., A_n\}$ is a set of attributes $S \subseteq R$ with the property that no two tuples t_1 and t_2 in any legal relation state r of R will have $t_1[S] = t_2[S]$

$\{k\}^+ =$ _____ ?

- A **key** K is a superkey with the *additional property* that removal of any attribute from K will cause K not to be a superkey any more.

Definitions of Keys and Attributes Participating in Keys (Cont.)

- If a relation schema has more than one key, each is called a **candidate key.** One of the candidate keys is *arbitrarily* designated to be the **primary key,** and the others are called *secondary keys*.

First Normal Form

- Disallows composite attributes, multivalued attributes;
- Disallows attributes whose values *for an individual tuple* are non-atomic
- Considered to be part of the definition of relation

3NF

- X-> Y is **trivial** if Y ⊂ X, otherwise, it is nontrival.
- A relation schema R is in **third normal form** (**3NF**) if, whenever a non-trivial FD X -> A holds in R, then either:

  (1) X is a superkey of R, or

  (2) A is a prime attribute of R

BCNF (Boyce-Codd Normal Form)

- A relation schema R is in **Boyce-Codd Normal Form** (**BCNF**) if whenever an nontrivial FD X -> A holds in R, then X is a superkey of R
- Each normal form is strictly stronger than the previous one
  - Every 2NF relation is in 1NF
  - Every 3NF relation is in 2NF
  - Every BCNF relation is in 3NF
- There exist relations that are in 3NF but not in BCNF

These slides are based on the textbook:

R. Elmasri and S. Navathe, *Fundamentals of Database System*, 7th Edition, Addison-Wesley.